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Natural rubber membranes with gold nanoparticles for application as surface-enhanced Raman scattering (SERS) substrate

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Abstract

Natural rubber (NR) membrane was prepared through casting method at 65ºC and applied as active substrate for the *in situ* reduction of gold nanoparticles. The gold aqueous solution was heated to 80° C and then the previously prepared membranes were immersed into this solution for 6, 9, 15, 30 and 60 minutes for the gold reduction process. The growth kinetics of gold nanoparticles was monitored by ultraviolet and visible absorption spectroscopy (UV-Vis) and the membranes structural analysis was carried out by the FT-IR spectroscopy. The UV-Vis results of NR/Au membranes, exhibited in figure 1, show the presence of a band near 560 nm attributed to surface plasmon absorption of gold nanoparticles. With the increase of reduction time, it was observed a shift in the spectra for greater values of absorption, indicating that a higher amount of gold nanoparticles are present in the NR membranes. The FT-IR analysis showed a shift in the bands for the primary amides stretching at 1651 cm^{-1} and secondary amides at 1544 cm^{-1} attributed to the reduction process of gold nanoparticles. As a possible application, nanostructured films composed by a phenothiazine compound (methylene blue, MB) were deposited onto the NR/Au membranes using dip-coating technique and further characterized by micro-Raman spectroscopy. The optimized conditions (reduction time) to observe the SERS (*surface-enhanced Raman scattering*) effect of the MB film was investigated to check the possibility of using NR/Au as a SERS active substrate. The results showed that the NR containing gold nanoparticles, for all reduced times used, promote the enhanced of MB Raman scattering signal when compared to results obtained for MB films deposited in a NR membrane without gold nanoparticles. In addition, figure 2 reveals a dependence of the SERS signal on the quantity of adsorbed gold nanoparticles onto the membranes (reduction time).

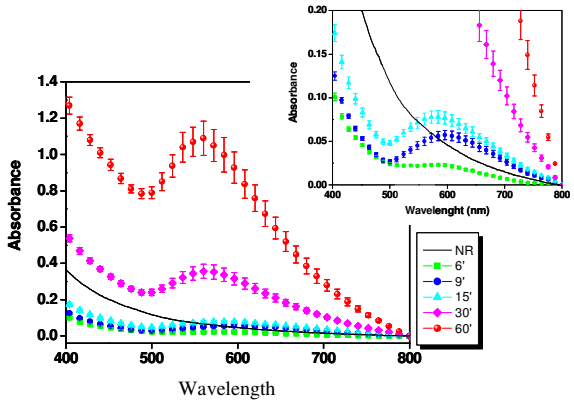

Figure (1): UV-vis absorption spectra for the NR/Au growth kinetics reduced at the 6, 9, 15, 30 and 60 minutes.

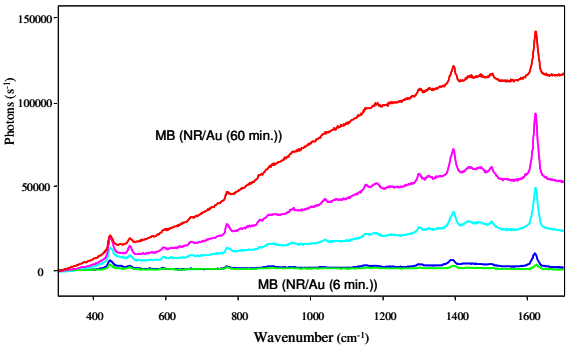

Figure (2): SERS analyses for MB deposited onto NR/Au membranes reduced at the 6, 9, 15, 30 and 60 minutes.

Acknowledgments

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